

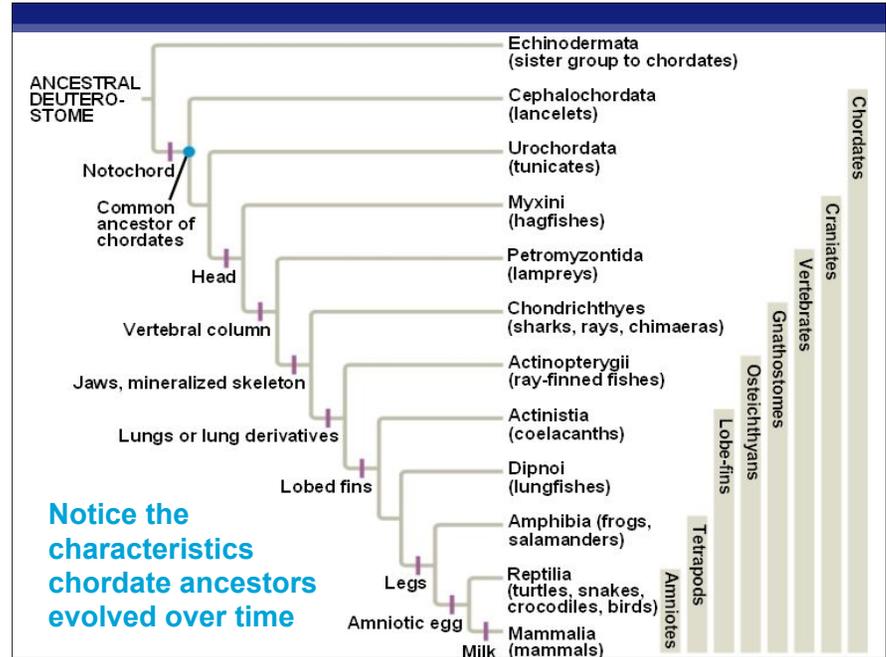
Phylum Chordata

Chordates

- ◆ Multicellular
- ◆ Bilaterally symmetrical triploblasts
- ◆ Coelomates with full-fluid filled gut tube
- ◆ Deuterostomes
- ◆ Organ system level of organization
- ◆ Cephalized - *has a head*
- ◆ Endoskeleton of cartilage and/or bone and a few with an exoskeleton.
- ◆ Fully-lined thoracic and abdominal cavity - *lined by epithelial cells*
- ◆ In early stages of development, all chordates have a subpharyngeal gland for concentrating iodine.
 - This gland is homologous to the thyroid gland in humans.



AP Biology

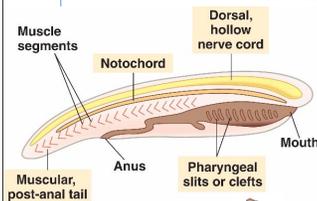


Phylum Chordata

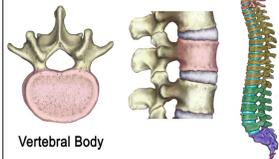
Four key Characteristics set chordates apart

1. Notochord

- ◆ A longitudinal flexible rod located dorsally between the digestive tube and the nerve cord



- ◆ Large fluid-filled cells encased in stiff, fibrous tissue: **cartilage**
- ◆ A skeletal structure present in **all** chordate embryos and **some** adults
- ◆ Provides skeletal support and a flexible structure for **muscles** to work against



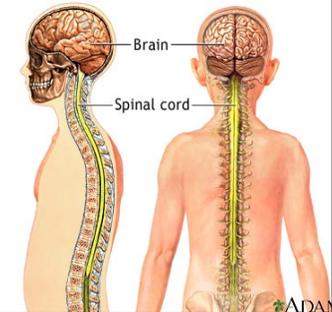
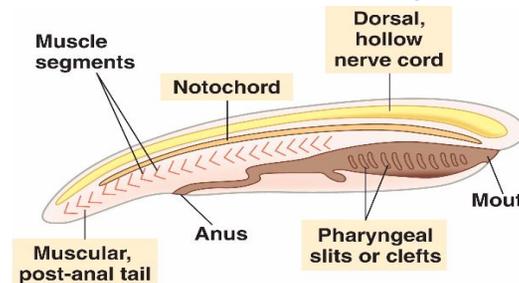
- ◆ A complex jointed endoskeleton develops around notochord in **vertebrates**
- ◆ Adult retains remnants of embryonic notochord
- ◆ In humans, notochord develops into **gelatinous disks** between vertebrae that cushion each vertebrae

Phylum Chordata

Four key Characteristics set chordates apart

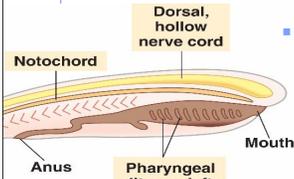
2. Dorsal, hollow Nerve Cord

- ◆ Develops from plate of ectoderm
 - ◆ Ectoderm rolls into a tube located dorsal to the notochord
 - Other animals only have **SOLID** nerve cords
 - Often located **ventrally** not dorsally
- ◆ Develops into **central nervous system**:
 - ◆ The brain and the spinal cord



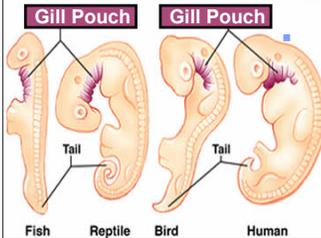
Phylum Chordata

- Four key Characteristics set chordates apart
 - 3. Pharyngeal Slits or Clefts



- All chordate embryos have this series of pouches separated by grooves along the sides of the pharynx = **Pharyngeal Clefts (Gill Pouches)**

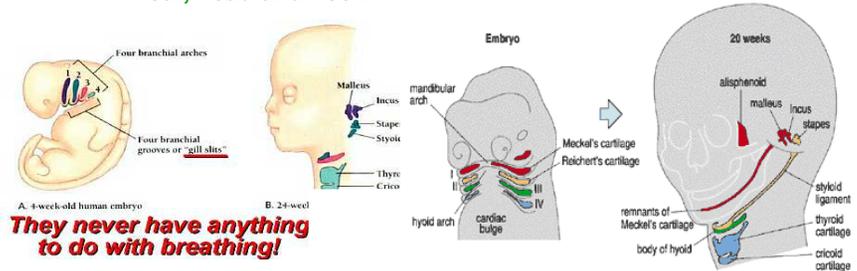
Embryos and Evolutionary History



- Pharynx is the region just posterior to the mouth
- Grooves often develop into slits that open to the outside of the body = **Pharyngeal Slits**
- Allow water to enter mouth and exit body without passing through entire digestive tracts from mouth to anus

Phylum Chordata

- a) **Invertebrate chordates**
 - Slits become suspension feeding devices
- b) **Vertebrates without limbs**
 - Slits become gill slits of gills (fish)
- c) **Tetrapods (like humans)**
 - Clefts do not become slits and develop into parts of the ear, head and neck



They never have anything to do with breathing!

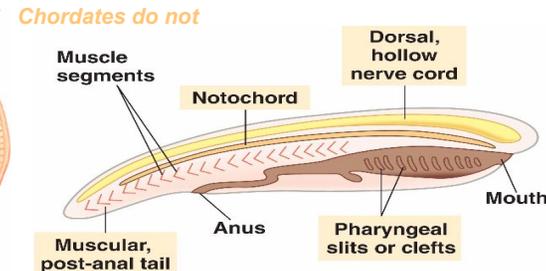
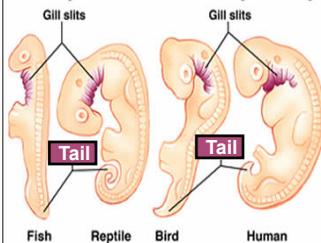
Phylum Chordata

- Four key Characteristics set chordates apart
 - 4. Muscular Post-Anal Tail



- Tail extends posterior to the anus
 - May be reduced during the course of embryological development
 - Recall that non-chordates have digestive tracks that extends nearly the whole length of the body

Embryos and Evolutionary History



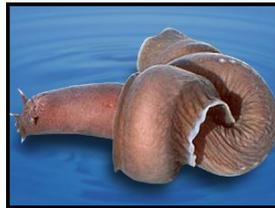
Three subphyla of Chordata

- Subphylum Urochordata - The Tunicates**
 - Larval stage possesses all of the chordate characteristics
 - Most of these characteristics are lost when the larvae undergo metamorphosis and emerge as adults
 - Adult stage are primarily sessile marine filter-feeders
- Subphylum Cephalochordata - The Lancelets**
 - Possesses all of the chordate characteristics throughout life cycle
 - dorsal nerve cord
 - notochord
 - gill slits
 - Burrow into sand and use mucous-secreting organs to filter-feed
 - Feeble swimmers
- Subphylum Vertebrata - The vertebrates**



The Craniates

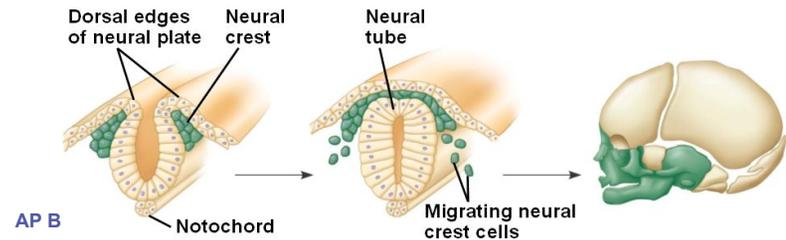
- **Craniates (Cranium = skull) are chordates that have evolved a head!**
 - ◆ **The head consists of a brain at the anterior end of the dorsal nerve cord, eyes and other sensory organs, and a skull**
- **Enabled chordates to:**
 1. **Coordinate more complex movements**
 2. **Have more complex feeding behavior**
- **Class Agnatha - the jawless fish**
 - ◆ **Examples: lamprey, hagfish**
 - **no jaws**
 - **most are parasitic fish**
 - **very diverse group in past**
 - **Today, only a few species are still hanging on**



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The Craniates

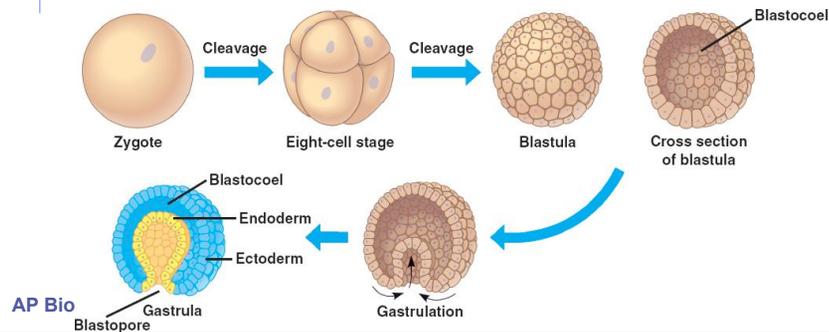
- **Craniates unlike other chordates possess two clusters *Hox* genes (duplication of genes)**
 - ◆ **This adds additional genetic complexity so craniates could develop more complex morphologies**
 - **Lancelets and tunicates have only one copy**
- **Unique features of craniate development = **Neural Crest****
 - ◆ **Collection of cells that appears near the dorsal margins of the closing neural tube in an embryo**
 - **These cells migrate in embryo and become teeth, bones and cartilage of skull, inner layer (dermis) of skin of the face, neurons, etc..**



AP B

Craniate Gastrulation leads to Organogenesis

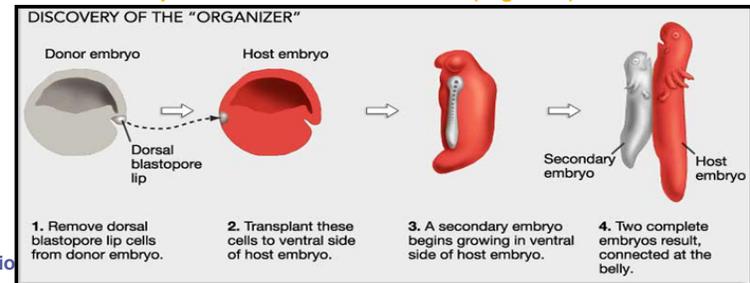
- **Recall that after cleavage, during gastrulation three germ layers form in coelomates**
 - ◆ **Gastrulation: Period of cell migrations around blastopore (an organizing center) which converts embryo from hollow ball of cells into a 3-layered stage called gastrula**
 - **Germ layers: Endoderm, mesoderm, ectoderm**



AP Bio

Craniate Gastrulation leads to Organogenesis

- **Organogenesis: Organ Formation**
 - ◆ **Involves more localized shape changes in tissues and individuals cells**
 - **First evidence of organ building is the appearance of tissue folds and splits and dense clustering of cells**
 - ◆ **In chordates notochord develops first then neural tube which will become the Central Nervous System (brain and spinal cord)**
 - **Occurs via organizing centers**
 - ◆ **Groups of cells that control fate of (organize) other cells**

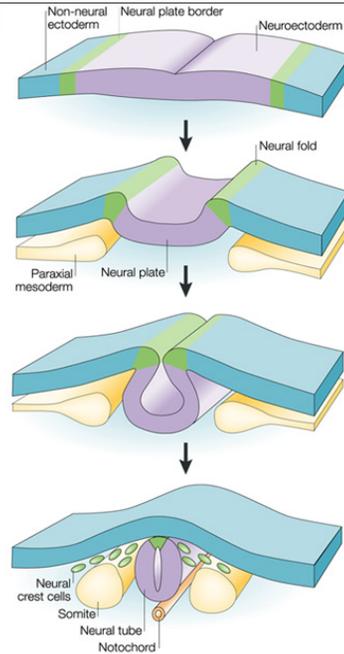


AP Bio

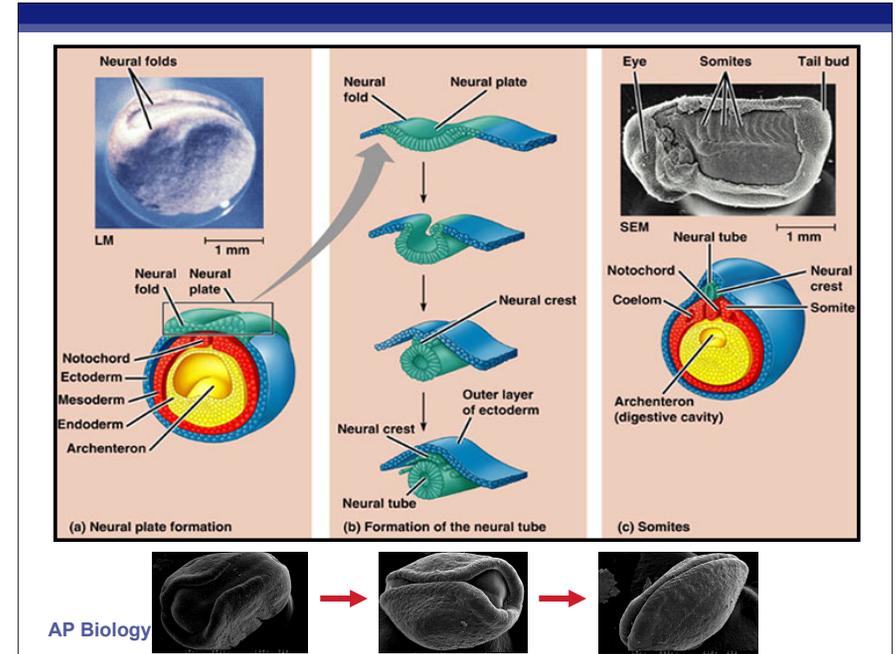
Example of Organogenesis: Neurulation

Neurulation: formation of nervous system via neural tube formation

- ◆ **Neural plate** (forms from ectoderm) is a flat tissue surface that migrates to form tubes
 - **Neural tube** = Forms from neural plate and becomes the **Central Nervous System** (brain & spinal cord)
 - ◆ **Notochord** forms from the mesoderm and forms cartilage-like backbone
 - ◆ Condensations of cells of the mesoderm next to notochord separate into blocks called **somites**
 - **Somites** develop into segmental structures such as vertebrae



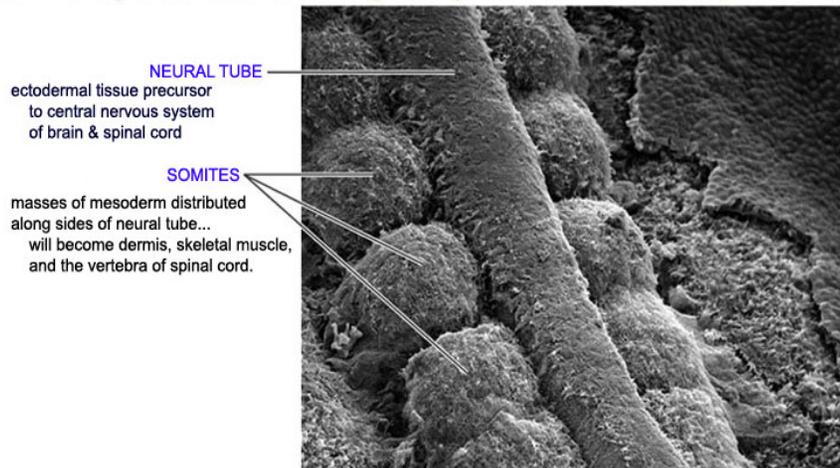
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Example of Organogenesis: Neurulation

SOMITES: segmented mesodermal tissue aligned along the neural tube from anterior to posterior embryo



Phylum Chordata

Subphylum Vertebrata - The Vertebrates



- ◆ Deuterostomes
- ◆ Craniates (possessing a skull) with a segmented **BACKBONE** or **SPINAL COLUMN**.
 - Have a dorsal (along the back) set of nerves encased in bones that replaces the notochord
 - Have a distinct, differentiated head
 - ◆ 50,000 species including amphibians, fishes, reptiles, birds, & humans
- ◆ Vertebral column - a winning evolutionary design



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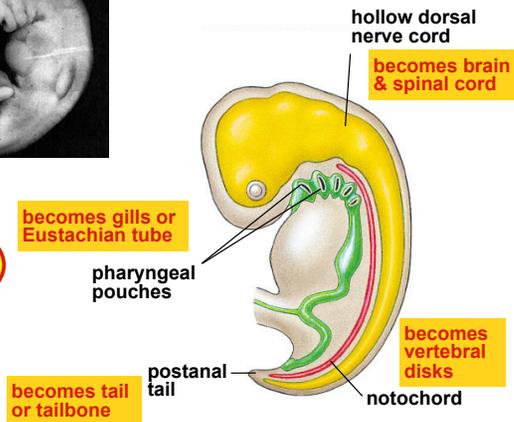
- **Result: Fastest runners, highest fliers, deepest divers, most agile climbers, and the best AP Biology students that ever lived ;)**



Phylum Chordata, Subphylum Vertebrata

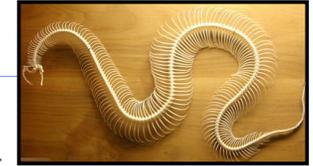


Oh, look...
your first
baby picture!



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Phylum Chordata, Subphylum Vertebrata

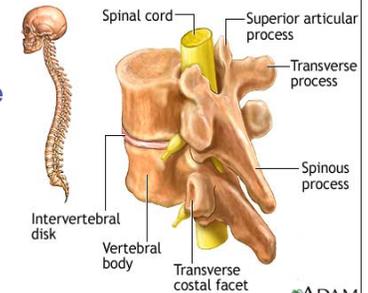


- **Vertebrates like chordate:**
 - ◆ Dorsal cartilaginous **Notochord** present at some point in development
 - ◆ **Pharyngeal Cleft or Slits** present during development
 - ◆ Dorsal **hollow Nerve Cord**
 - ◆ **Post-anal Tail**
 - **Primitively muscular and used for locomotion**
 - ◆ **Subpharyngeal gland** to concentrate iodine
 - **Thyroid gland (in Vertebrates)**

- **Vertebrate also have...**
 - ◆ **Extensive skull and a backbone**
 - **Vertebrae encased spinal cord**
 - ◆ **Has taken over the mechanical roles of the notochord**
 - **In humans notochord left overs are the vertebral disks that are sandwiched in between the vertebrae**
 - **Skull encased brain - protects**



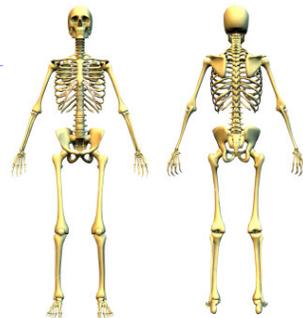
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ADAM

Phylum Chordata, Subphylum Vertebrata

- **Vertebrate also have...**
 - ◆ **More complex nervous systems & internal skeletal systems**
 - **Increased efficiency of two tasks:**
 1. **Capturing food**
 2. **Avoiding predators/being eaten**
 - ◆ **Jointed appendages**
 - ◆ **Immune & lymphatic systems for defense**
 - ◆ **Endocrine systems** for coordinating body activities
 - ◆ **Extracellular digestion** in a complete digestive tract
 - ◆ **Closed circulatory system**
 - ◆ **Excretion and osmoregulation** through paired kidneys
 - ◆ **Respiration** through skin, gills or lungs
 - ◆ **Sexual reproduction** and the organisms are dioecious



AP Biology

470 mya

Vertebrates: Gnathostomes

- **Jawed vertebrates**
 - ◆ **Includes sharks, ray-fin fish, lobe-fin fish, amphibians, reptiles (including birds) and mammals**
 - **Jaw (with teeth)** is a hinged structure that enable organism to **grip food firmly and slice them**
 - ◆ **See another duplication of Hox genes resulting in 4 Hox genes**
 - **Allowed for further complexity of development in gnathostome embryos**
 - ◆ **Forebrain is enlarged**
 - ◆ **Enhanced sense of smell and vision**
- **Class Chondrichthyes**
 - ◆ **The cartilaginous fish**
 - **Examples: sharks, rays, skates**
 - ◆ **Endoskeleton is composed entirely of cartilage**
 - ◆ **Two-chambered heart**
 - ◆ **numerous rows of teeth**
 - ◆ **internal fertilization and separate sexes**



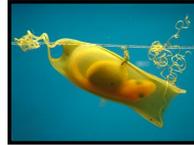
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Development of Young



■ **Ovoviviparous (Most sharks)**

- ◆ Fertilized eggs retained in organ called oviduct - *advantage protects egg from predators outside mother's body*
 - The egg's yolk and fluids secreted by glands in the walls of the oviduct nourishes the embryos.
- ◆ Hatching occurs in the uterus
- ◆ Young are born alive and fully functional



■ **Oviparity**

- ◆ Lay eggs that hatch outside of shark's body
- ◆ Egg case has consistency of leather.

■ **Viviparity**

- ◆ A *placental* link inside mother to the developing young exists and mother continually nourishes developing young
- ◆ The young are born alive and fully functional

Two documented cases exist in which a female shark who has not been in contact with a male has conceived a pup on her own through a process known as *parthenogenesis*.